DOCUMENT RESUME

ED 171 591 SE 027 847

TITLE	Tornado Preparedness Planning.
INSTITUTION	National Oceanic and Atmospheric Administration (DOC), Rockville, Md. National Weather Service.
PUB DATE	Dec 78
NOTE	33p.; Figures on maps may be marginally legible
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 003-017-00434-1; $1.40)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Alarm Systems; Civil Defense; *Community Coordination; *Community Education; Community Leaders; Earth Science; *Emergency Programs; *Meteorology; *Methods; Safety Education; School Safety
IDENTIFIERS	*National Weather Service

ABSTRACT

This pamphlet contains a set of guidelines for community leaders interested in developing preparedness plans for tornadoes and severe thunderstorms. Included in the guide is a list of the types of officials and agencies which should be involved in planning meetings. A set of suggestions for developing a community communications network and pre-season actions for local institutions and homeowners is presented. The guidelines are intended to develop community awareness and coordinated action by all persons or agencies involved and to ensure that proven procedures are adopted. A section of the text deals with educating the public concerning how to protect themselves from the hazards of these devastating natural phenomena. (SA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED171591

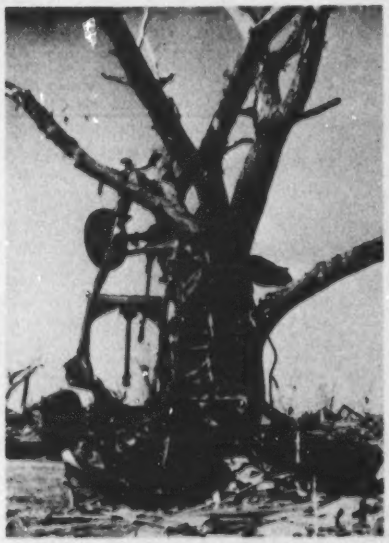
U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration

TORNADO PREPAREDNESS PLANNING

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

SKYWARN



SE 027 847

TORNADO PREPAREDNESS PLANNING

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator

National Weather Service
George P. Cressman, Director

December 1978

PREFACE

In June 1973, the Defense Civil Preparedness Agency (DCPA) and the National Oceanic and Atmospheric Administration (NOAA) signed an agreement to coordinate the community natural disaster program. It designates the DCPA On-Site Assistance program as the means for carrying out much of the disaster preparedness planning effort at the local government level. We believe this agreement will lead to improved coordination in community disaster planning throughout the Nation.

The DCPA, state Civil Defense, and the National Weather Service (NWS) of NOAA have been cooperating in planning and coordinating community preparedness meetings and drills. This agreement will provide a better organized and more systematic effort by both agencies.

The tornado preparedness planning information in this pamphlet is to aid the local leaders and the On-Site Assistance teams in developing community preparedness plans. These plans are needed (1) to ensure coordinated action by everyone involved (e.g., warning agencies, local officials, law enforcement agencies, cooperating news media, rescue and medical agencies, disaster relief agencies, and volunteer communications groups); (2) to ensure the adoption and implementation of proven practices and procedures; and (3) to carry out a public education program concerning the threat of tornadoes and severe thunderstorms and the measures that individuals should take to safeguard themselves when they are in the path of these devastating natural hazards.

Community tornado preparedness plans should be commensurate with the frequency of such storms, the population density, and the resources of the community.

George P. Cressman
Director, National Weather Service

CONTENTS

Chapter		Page
	Preface	iii
I	Introduction	1
	What Can Be Done	1
	How to Start Doing It	1
II	Tornado Preparedness Planning	3
	National Weather Service Cooperation	3
	The First Meeting	3
	The Tornado Preparedness Committee	4
III	Building Blocks for a Tornado Preparedness Plan	5
	The Published Plan	5
	Example of Section 5 Contents	6
IV	Tornado and Severe Thunderstorm Reporting Networks	8
	Establishment of Networks	8
	Training of Spotters	9
	Operation of the Spotter Network	9
	Appreciation of the Spotters' Efforts	10
	Practice Drills	10
	Special Supplemental Spotters	10
V	Communications and Distribution of Warnings	11
	Necessary Internal Communications Arrangements	11
	Reaching the Public	11
	Reaching the Broadcast Stations	12
	Other Means	12
	Audible Warnings	13
VI	Public Education on Tornadoes and Severe Thunderstorms	14
	Recommended Safety Rules and Pre-Season Actions	15
	Special Safety Rules and Pre-Season Actions for Schools	16
	Lightning Safety Rules	16
VII	Medical and Hospital Tornado and Severe Thunderstorm Plans	18
VIII	Post-Disaster Relief and Rehabilitation	19
IX	Severe Local Storm Warning Service	20
X	Description and Climatology of Tornadoes and Severe Thunderstorms	24
	Characteristics of Tornadoes	24
	The Work of Winds and Pressure	25
	Wind Speeds	25
	The Casualty and Damage Potential	25
	Major Tornadoes	26
	Characteristics of Severe Thunderstorms	26

List of Illustrations

Figure		
1.	Tornado Incidence by State and Area, 1953-1971	26
2.	Deaths From Tornadoes, 1953-1971	27
3.	Threat Rating From Tornadoes, 1953-1969	27
4.	Tornado Incidence by Month, 1953-1971	28

List of Tables

Table		
1.	Guide for Contact with National Weather Service Regional Headquarters	2
2.	Suggested Attendance for a Tornado Preparedness Planning Meeting	4

CHAPTER I—INTRODUCTION

Your wife is in the kitchen, preparing the evening meal. Your children are playing outdoors.

The broadcast program is suddenly interrupted.

The announcer says, urgently: "The U.S. Commerce Department's National Weather Service has just issued the following Tornado Warning Bulletin"

> A "TORNADO WARNING IS IN EFFECT UNTIL 7 P.M. FOR PERSONS IN [YOUR COUNTY]. A TORNADO WAS SIGHTED SIX MILES SOUTHWEST OF [YOUR TOWN] AT 5:15 P.M. THIS TORNADO IS MOVING TOWARD THE NORTHEAST AT TWENTY MILES PER HOUR. IF A TORNADO OR THREATENING CONDITIONS ARE SIGHTED . . . BE PREPARED TO MOVE TO A PLACE OF SAFETY."

What does this mean to your wife? What should she do to protect herself and the children? Has she ever been told what shelter to seek, or how to recognize an approaching tornado? Has your community developed plans for warning her neighborhood—for recommending shelter areas—for quick rescue operation if a tornado strikes?

If your community is among those which have developed tornado preparedness plans, your wife and children will have a much better chance of survival and rescue if your neighborhood, or even your house, is struck.

If, however, your community is among those which have not yet developed and established a Tornado Preparedness Plan, the development of an adequate plan should be considered seriously—NOW. This pamphlet gives you information on what can be done and how to do it.

The potential for loss of life and property from tornadoes increases year by year. As open fields become residential areas, the target for disaster broadens. New people move into the community, often unaware of what can happen. Old and new residents and education concerning the threat of natural hazards and how to protect themselves. This education should be arranged by the local leadership as part of tornado preparedness planning. This leadership can also fit tornado preparedness planning to the resources and capabilities of the comunity.

What Can Be Done?

A Tornado Preparedness Plan can be developed to fit any size community, from a small town to a large metropolitan area. Plans are needed even for communities where no tornado has ever struck. *Every year, places that have never been struck before join the list of tornado disaster locations.*

Can anything really be done to minimize a tornado disaster? Yes—by public education in the application of effective procedures, timely wide-spread warnings can be applied to save many people from death or injury when a tornado strikes. The same system can be used to spread the word when severe thunderstorms pass over an area, in order to reduce deaths and injuries from lightning, high winds, and destructive hail.

Although a community may have a disaster plan for other hazards (man-made or natural), tornadoes and severe thunderstorms are "short-fuse" hazards and can strike suddenly, then move quickly across an area. Special cooperative arrangements need to be made to watch for them, detect them as soon as possible, and quickly warn the areas in the path of their movement, so that people can go to proper shelter immediately. Preplanned rescue and relief operations should be ready to start as soon as disaster strikes.

How to Start Doing It

NOAA's National Weather Service (formerly the Weather Bureau) started its severe local storm forecast and warning service in 1953. Since then, with improved techniques and communications—with expanded and intensified cooperation from the news

media and from authorities in charge of public protection, rescue, and relief—and with the valued help of individuals who watch for tornadoes and severe thunderstorms and make quick reports to area offices of the National Weather Service—the average number of deaths and injuries from these hazards has decreased considerably.

Each National Weather Service office in the United States has been assigned the responsibility for arranging for the distribution of watches and warnings of severe local storms, including tornadoes, throughout a number of counties. Every county in the United States is served by an office of the National Weather Service responsible for issuing pertinent warnings to it.

Table 1 lists by States the National Weather Service Regional Headquarters which should be contacted, by mail or telephone, to find out which office should cooperate with your group of local authorities in developing your community's tornado preparedness plan. They will be glad to arrange to have a representative meet with you to discuss any points needing clarification.

Act now! You may save residents of your community from death or injury *this* year—and for many years to come.

Table 1—GUIDE FOR CONTACT WITH NATIONAL WEATHER SERVICE REGIONAL HEADQUARTERS

States in Eastern Region:

Connecticut	North Carolina
Delaware	Ohio
Maine	Pennsylvania
Maryland	Rhode Island
Massachusetts	South Carolina
New Hampshire	Vermont
New Jersey	Virginia
New York	West Virginia

Address: Director, Eastern Region
National Weather Service, NOAA
585 Stewart Avenue
Garden City, New York 11530
Telephone: (Area Code 516) 248-2101

States in Southern Region:

Alabama	Mississippi
Arkansas	New Mexico
Florida	Oklahoma
Georgia	Tennessee
Louisiana	Texas

Address: Director, Southern Region
National Weather Service, NOAA
819 Taylor Street
Fort Worth, Texas 76102
Telephone: (Area Code 817) 334-2668

States in Central Region:

Colorado	Minnesota
Illinois	Missouri
Indiana	Nebraska
Iowa	North Dakota
Kansas	South Dakota
Kentucky	Wisconsin
Michigan	Wyoming

Address: Director, Central Region
National Weather Service, NOAA
601 E. 12th Street
Kansas City, Mo. 64106
Telephone: (Area Code 816) 374-7000

States in Western Region:

Arizona	Nevada
California	Oregon
Idaho	Utah
Montana	Washington

Address: Director, Western Region
National Weather Service, NOAA
Box 11188, Federal Building
125 South State Street
Salt Lake City, Utah 84111
Telephone: (Area Code 801) 524-5500

State of Alaska:
Address: Director, Alaska Region
National Weather Service, NOAA
632 6th Avenue
Anchorage, Alaska 99501
Telephone: 272-9522

State of Hawaii, and Pacific Possessions:
Address: Director, Pacific Region
National Weather Service, NOAA
Bethel-Pauahi Building
1149 Bethel Street
Honolulu, Hawaii 96813
Telephone: (Area Code 808) 546-5680

Public Information Office
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852
Telephone: (Area Code 301) 496-8243

CHAPTER II—TORNADO PREPAREDNESS PLANNING

Your community may be a metropolis, or a suburban area, or a smaller city, or a town, or a farming or ranching area. In most cases it does not have an office of the National Weather Service located within it. But in every case, a National Weather Service office is responsible for providing alerting information and for warning your community concerning severe local storms, including severe thunderstorms and tornadoes.

Tornado preparedness planning consists of developing arrangements and communications between the responsible warning agency and the local county, and state authorities and agencies responsible for public protection, safety, rescue, and relief—so that, when necessary, the most appropriate immediate action can be taken. The planning covers the arrangements designed to ensure concerted local action when the emergency arises.

National Weather Service Cooperation

Tornado Preparedness Planning adjusts this Basic Warning System to the size, needs, and resources of your particular community. It is here that your cooperating National Weather Service official enters into the picture. He will explain in full detail the concept of a Tornado Preparedness Plan to fit your community. *He can do this best in a meeting.*

He knows your community's severe local storm climatology.

He can tell you how the National Weather Service provides severe local storm watches, warnings, progress statements, and all-clear bulletins.

He can advise you how to organize spotter networks and communications for quick detection and reporting of the formation and approach of tornadoes and severe thunderstorms.

He can inform you of successful planning by other communities.

And he can explain your part in distributing warnings and in arranging for public education on tornadoes and severe thunderstorms.

The First Meeting

Table 2 shows suggested attendance for a Tornado Preparedness Planning Meeting. From the experience of communities of various sizes that have developed tornado preparedness plans, comprehensive representation at the organizing meeting leads to maximum cooperation and rapid development of the plan.

The interested news media—newspapers, radio stations, and television stations—should be invited. The cooperating National Weather Service official will assist by making background material available in advance.

The responsibilities of agencies taking part in a community warning system are:

WARNING AGENCY (NATIONAL WEATHER SERVICE)

1. Constantly collects reports. Closely follows weather conditions.
2. Assesses severe weather potential.
3. Issues *"Watch"* bulletins and severe weather statements.
4. If severe weather is sighted or indicated, issues *"Warning"* bulletins.
5. Monitors for additional threats; continues severe weather statements; and issues new warnings when necessary.
6. Issues All-Clear bulletins.

LOCAL AGENCIES

1. Alert personnel when *"Watch"* is issued and help disseminate Watches, Warnings, severe weather statements and All-Clears.
2. Assist in reporting occurrences of severe weather.
3. If severe local storm threatens community, sound local warning immediately.
4. Act to protect, rescue, and relieve public during and after disaster.
5. Feed back information on occurrences to warning agency.

Table 2—SUGGESTED ATTENDANCE FOR A TORNADO PREPAREDNESS PLANNING MEETING

NOTE: Selections from this list will vary according to the size, location and geography of the community, etc. In some cases more than one official of each category should be invited (e.g., when more than one jurisdiction is involved).

Community Head or Heads (Mayor, Manager, Chairman of Board of Supervisors, President of Council, etc.)
Newspapers serving community
Radio and Television Stations serving community (including those serving from outside the community)
Community Police Head
Community Civil Defense Director
County Civil Defense Director
Appropriate Red Cross Chapter Chairman, Disaster Chairman, and Disaster Service Representative
County Law Enforcement Head
District or Area State Law Enforcement Agency
Medical Association
Hospital Heads
Superintendent of Public Schools
Heads of Private Schools and of Colleges and Universities
Head of Fire Protection Agency
Radio Amateurs, Citizens' Band Radio Groups, Citizens' Radio Service
State National Guard
District Engineer, U.S. Corps of Engineers
Federal Communications Commission Regional Liaison Officer
FCC's State Industry Advisory Committee and/or Area Industry Advisory Committee
Public Utilities
Manager of Public Transit
Community Engineering Department
Superintendent of Streets and Public Works
Civil Air Patrol
Airport Manager
Federal Aviation Administration Representative
Commanders of U.S. Military Facilities in or near Community
U.S. Coast Guard (where applicable)

Consideration could also be given to inviting:

Governor's Representative (especially when more than one State is involved)
State Director of Civil Defense
Regional Officer of the Office of Civil Defense
Regional Officer of the Office of Emergency Preparedness
Public Health Service, HEW, Representative
Consumer and Marketing Service, Department of Agriculture, Representative
General Services Administration Representative
State Board of Education

The Tornado Preparedness Committee

The officials and representatives at the meeting will know the resources available to them, and the general disaster plans applicable to the community or area. They will know which people should be brought together to develop the various parts of the Tornado Preparedness Plan. These people will need *a focal point—a standing Tornado Preparedness Committee*—to decide upon the coordination of the various parts of the Plan, and to oversee and ensure its implementation and continuing operation. The cooperating National Weather Service official will be available to help in the Committee's work.

The Tornado Preparedness Committee's membership should comprise representatives of the vital agencies of the community or area. Subcommittees (to work out the general ideas of the full committee) should be formed to work out the following parts of the plan:

Spotter Networks (see Chapter IV)
Communications Networks and Warning Dissemination (see Chapter V)
Public Education on Tornadoes and Severe Thunderstorms (see Chapter VI)
Medical and Hospital (see Chapter VII)
Post-Disaster Relief and Rehabilitation (see Chapter VIII)

When your Tornado Preparedness Plan is agreed upon, the Committee should have it reproduced, distributed, and activated with appropriate, continuing publicity to ensure maximum awareness on the part of the public and all participating agencies.

Once the Tornado Preparedness Plan is in operation, the Tornado Preparedness Committee should meet at least once a year, just before the beginning of the tornado season (usually by early February). It should fill any vacancies in its membership; review the Plan and make any necessary changes; reacquaint the members with the Plan, including familiarization of any new members; make plans for renewal of the public's education on tornadoes and severe thunderstorms; and make plans for practice drills. It may also accomplish an important function in case of disaster by holding a timely post-disaster review at a special meeting to determine the effectiveness of the action taken, and to make necessary changes in the Tornado Preparedness Plan to improve its application.

Chapter III presents a building-block approach to this planning that will make decisions easier. It also includes a summary treatment showing how all elements in the plan dovetail to provide a complete warning system. Chapters IV, V and VI deal in detail with those aspects of planning which might be termed "minimizing danger." Information concerning medical and post-disaster procedures, Weather Bureau operations, and Severe Weather Climatology is outlined in the remaining Chapters.

CHAPTER III—BUILDING BLOCKS FOR A TORNADO PREPAREDNESS PLAN

Depending upon the size and complexity of a community or area, a Tornado Preparedness Plan may include arrangements from the simple to the elaborate.

The plan will also vary with the facilities available for dissemination of Watches and for quick local dissemination of Warnings (sirens, local broadcast stations, etc.).

All plans have in common certain basic arrangements:

1. Indication of the National Weather Service office responsible for Warnings.
2. A tornado and severe thunderstorm reporting network.
3. One or more Warning Centers.
4. Communications for dissemination of Watch bulletins and Warning bulletins and for alerting safety, rescue, and relief agencies.
5. Provisions for alerting schools, factories, and other places where people are ordinarily congregated, to the need to activate a supplemental watch on threatening weather conditions for their own immediate benefit.
6. Provisions for alerting and warning people in outlying areas.
7. Specific, detailed provisions for action to be taken when a tornado or severe thunderstorm strikes.
8. Warning lists, and rosters of key personnel and alternates.
9. Brief, clear reference information on steps that should be taken by the public to be prepared for tornado and severe thunderstorm strikes—such as the best places to take shelter, plans for the safety of school children, and availability of battery-operated radios.
10. Information on actions to be taken after a disaster, and availability of food, shelter, medical supplies, water, fire prevention, sanitation, and military assistance.

The Published Plan

Pertinent parts of the Tornado Preparedness Plan that have been worked out by subcommittees and approved by the Tornado Preparedness Committee should be reflected briefly and clearly in a published pamphlet or brochure, which should be kept up-to-date by spot revisions during the severe storm season and by periodic revision.

Suggested contents are:

Section 1—Specification of the community or area to which the plan applies, and of the responsible National Weather Service office; and definition of "Tornado Watch," "Tornado Warning," "Severe Thunderstorm Watch," "Severe Thunderstorm Warning," "Severe Weather Statement," and "All-Clear Bulletin."

Section 2—A chart and keyed list of tornado reporting network locations.

Section 3—Location(s) of Warning Center(s) and a list of their personnel and alternates, together with home and business telephones.

Section 4—List of communication channels for:

—Transmitting severe weather spotters' reports of sightings to Warning Center(s) and to the National Weather Service;

—Dissemination of Watch bulletins (including local and non-local radio and television stations serving the area, and hours of operation);

—Dissemination of Warnings, Severe Weather Statements, and All-Clear bulletins;

—Alerting special meetings, sports events, and other non-routine gatherings of the public;

—Alerting and warning people in outlying areas;

—Alerting local authorities, when a Watch is issued, and for informing them immediately when a Warning is issued;

—Alerting school systems, factories, and other points involving routine congregation of people; and

—Alerting and warning law enforcement agencies, hospitals, rescue and medical personnel, and relief agencies.

Section 5—Sequence of actions to be taken by the warning, law enforcement, medical, and rescue agencies when a tornado or severe thunderstorm approaches or is occurring in the area (step-by-step, from the spotter's report to the sounding of sirens or other local immediate warning, and on to the end of the threat). (See example, below.)

Section 6—List of immediate post-disaster actions—prevention and control of fires, turning off of electricity and gas in damaged areas (listing those responsible for acting, with alternates, and how to contact them), provision of emergency power and communications facilities, plan for emergency shelters, transportation and feeding, location of medical supplies and water supplies, and measures for prevention of disease.

Section 7—Brief guidance on how to obtain emergency support from other communities or the military when the usual local resources have proved inadequate to handle the emergency; and how to obtain longer-term rehabilitation assistance from State and Federal sources.

Section 8—Roster of Tornado and Severe Thunderstorm Reporting Network spotters by stations, with their telephone numbers; of key amateur radio personnel, with their telephone numbers, call-letters, and frequencies; and of other key personnel, and alternates, for ready reference.

Example of Section 5 Contents

When a Tornado Watch or a Severe Thunderstorm Watch is announced for the community or area to which the Tornado Preparedness Plan applies:

1. All concerned with dissemination of Watches and Warnings should carefully adhere to the term "Watch" when only a Watch applies and use the term "Warning" only when a Warning has actually been issued. The exact wording of each bulletin should be used, to ensure that its meaning is maintained.
2. The tornado reporting network should be activated (according to pre-planned procedures). Spotters hearing the Watch broadcast will commence their watch immediately.
3. Law enforcement reserve personnel should be called to duty or alerted by law enforcement heads.
4. If in session, all schools should be notified by the school headquarters of the commencement of a Watch, and their supplemental severe weather spotters should be alerted to commence a watch for severe weather conditions.
5. Supplemental severe weather spotters for factories, sports events, etc., should be alerted to commence watch.
6. The Watch should be distributed over all communications channels participating in the Tornado Preparedness Plan.
7. All Fire Department stations should be alerted and notified of the Watch by Fire Department headquarters.
8. Hospitals, medical personnel, and nursing and rest homes should be alerted, and should place their plans in effect.
9. Warning Centers will determine the relationship of their local areas to the area announced (in terms of counties, cities, or geographical boundaries) as covered by the Watch, and if in or near the Watch area, will alert (others, as arranged in the Plan).
10. Mobile radio-equipped severe weather spotters (as arranged in the Plan) will proceed to (designated points), and watch for tornadoes or severe thunderstorms. Sightings will be reported by (communications channels arranged) to Warning Center(s) and to the National Weather Service office.

When a tornado or a severe thunderstorm is detected:

1. Tornado and Severe Thunderstorm Reporting Network spotters--Report sighting *first* to Warning Center of community immediately in path of storm; *second*, by COLLECT telephone call to National Weather Service office, telephone number ..... (as given to Network members); or to the nearest law enforcement agency if the National Weather Service office cannot be reached. Law enforcement personnel in contact with (law enforcement center) report sightings to dispatcher over (channel); dispatcher report sightings to National Weather Service office by (communications channel arranged).
2. Local Warning Center sounds local alarm (sirens, bells, or other means arranged); and confirms sighting to National Weather Service office by (communications channel arranged).
3. National Weather Service office verifies location, determines direction of storm movement, and issues *Tornado Warning*, or *Severe Thunderstorm Warning* to radio and television stations by (communications channels arranged); and makes other distribution as follows: (per Tornado Preparedness Plan arrangements) to Warning Center(s) concerned; to law enforcement agencies; and to others on National Weather Service office's emergency warning lists.
4. Supplemental Tornado and Severe Thunderstorm Watchers at schools, factories, etc., in the area in the direction of the storm's path, will be alerted by (Tornado Preparedness Plan arrangements), and will warn occupants of the facility to take cover if the tornado or severe thunderstorm approaches.
5. Warning Centers, law enforcement agencies, and others receiving Warning and in position to do so, warn public directly (by sirens) (specify who activates), warn residents of rural areas, etc. Law enforcement officers on the street warn the public to take shelter.
6. Emergency broadcasts of Warning bulletins and severe weather statements by cooperating broadcast stations provide warning and indication of endangered locations, direction of tornado or storm movement, and brief advice on actions individuals should take for self-protection.
7. Rescue and relief agencies, alerted by special National Weather Service messages or by the broadcasts, prepare to proceed immediately to stricken area, as reported by law enforcement agencies or others.
8. National Weather Service office issues frequent Severe Weather Statements, reiterating Warnings, and issues Warnings for new areas as appropriate, as the storm condition moves on or as new tornadoes or severe thunderstorms form.
9. National Weather Service office issues All-Clear bulletins for successive areas as the threat ends.

CHAPTER IV—TORNADO AND SEVERE THUNDERSTORM REPORTING NETWORKS

Any person who has experienced the horror of seeing an ominous funnel suddenly appear from a thundercloud knows that a quick warning is necessary to save those in the path of a tornado. Tornadoes and severe thunderstorms are not always preceded by the issuance of Tornado Watches or Severe Thunderstorm Watches, because forecasting has not yet been developed to that point, although much research continues to improve the techniques. Immediate Warnings, based on reports of actual sightings, are of the utmost importance.

Watches are not Warnings.

The *Watch* tells people to go about their business, but to keep an eye on the sky and in touch with weather statements and Warnings issued by the National Weather Service. Watches are distributed to the public with the cooperation of the broadcast media.

The *Warning* tells people of an actual sighting or an indication by radar and urges those in the danger path to prepare to take immediate cover for protection against death or injury if the hazard is seen approaching them.

The *Watch* alerts law enforcement, rescue, and medical agencies. The *Warning* sets them in motion to rescue the injured at the earliest moment and to provide them with medical attention.

Even though a Watch may not have been issued, a tornado or severe thunderstorm sighting report can set in motion a Warning to communities in the path of a hazard in time for people to take cover, and shorten the time required for implementing post-disaster rescue and relief measures. Until techniques and equipment are developed to detect the early formation of all severe weather hazards, successful detection of tornadoes and severe thunderstorms will require the support of a dense network of storm reporters—"spotters"—and effective, quick reporting procedures.

The National Weather Service receives help from nearly 500 local SKYWARN networks but many more are needed. Nationwide, these networks are made up of thousands of public-spirited citizens and organizations.

Each network is organized around the needs of the area being served, with special consideration given to localities that are highly industrialized or heavily populated. In areas of the United States where severe local storms occur infrequently, such as the Far West, networks may be confined to interested groups such as State highway patrol and utility companies. But in the parts of the country subjected to frequent severe local storms—tornadoes and severe thunderstorms—networks should be located throughout all counties in the area of responsibility of a National Weather Service office. Spotters should be spaced closely enough to be able to detect all severe local storms, including those that occur during periods of reduced visibility caused by rain or darkness.

Ideally, trained spotters should be stationed at points about two miles apart within a radius of about 20 miles around a major population center. Heaviest concentrations of spotters usually should be to the southwest. An exception to this type of distribution would be a more uniform deployment around major coastal population centers in southeastern States which are threatened mostly by tornadoes associated with hurricanes. Such tornadoes may approach from an easterly direction.

Residents of several towns may form a mutual network, which may help to serve several towns as well as a nearby city, or in some cases cover an entire county or even a group of counties.

Establishment of Networks

A thorough survey should be made of networks that have been established for other purposes. These

may include radio amateur leagues, State and county Civil Defense units, multi-county fire departments, public utilities companies, industrial security groups, State, county, and local law enforcement agencies, and highway departments. These groups are trained to react capably to emergency situations and many have communications facilities for rapid reporting. Meetings should be arranged between the heads of these groups, their Communications Officer, the Tornado Preparedness Committee, and the cooperating National Weather Service official. The latter will explain the type of network needed and will request cooperation and participation in selecting and training spotters, and in developing and maintaining efficient procedures for storm reporting and Watch and Warning dissemination.

The law enforcement agencies, with their two-way communications facilities and mobility, are very effective in spotter networks. They can disseminate Watch bulletins, maintain a lookout for severe local storms, investigate rumored severe thunderstorms and tornadoes, activate local warning systems, and disseminate warnings. They can also quickly report disasters and direct rescue agencies to points needed.

Citizens' Band radio groups have been very cooperative in participating in the severe weather reporting networks. With their equipment, including mobile equipment safe from power outage, they can fan out quickly and report immediately when a tornado or severe thunderstorm is spotted, through a key operator acting as filter between them and the responsible National Weather Service office. The interest and enthusiasm of these groups is very high and their cooperation is very helpful. Other amateur radio groups have performed many sterling services in time of disaster to aid the stricken public.

There is a need for supplemental severe local storm spotters for schools, industrial plants, and large gatherings of people such as fairs or sports events during threatening weather conditions, or when the National Weather Service has issued a Tornado Watch or a Severe Thunderstorm Watch for the area. They should watch for storm development and approach, and report to someone inside when the school, factory, or gathering is threatened, so that a "take cover" alarm can be sounded.

News media generally are glad to cooperate with a Tornado Preparedness Committee by informing the public of the need for spotters. This often brings forth the right type of well-motivated private volunteers.

Training of Spotters

All SKYWARN spotters and reports are supplied with detailed instructional material by the National Weather Service. Included are copies of the brochure, "Tornado," "Tornado Safety Rules," "Spotter's Guide for Identifying and Reporting Severe Local Storms," and "Severe Local Storm Warning Service (and Tornado Statistics 1953–1969)." Spotters should have a thorough knowledge of tornado and severe thunderstorm characteristics, not only to ensure that they are able to recognize these hazards, but also to avoid erroneously reporting non-hazardous conditions and thereby generating needless warnings.

Illustrations in these brochures and information on the characteristics of severe thunderstorms and tornadoes that appear in Chapter X of this pamphlet will assist in training spotters to make proper recognition of severe weather conditions.

The National Weather Service also provides spotters with an instruction sheet, "Spotter Procedures for Reporting Severe Local Storms." The name and telephone number of the National Weather Service office to be called COLLECT when a tornado or severe thunderstorm is observed are filled in on the bottom of the instruction sheet. If feasible, an alternate office and number are also supplied in the event that the spotter has difficulty reaching the primary office by telephone. In addition each spotter is furnished with a wallet-sized card containing the telephone numbers to be called, in case he is away from his usual location when he sights severe weather. In most instances, telephone numbers for reporting severe weather are unpublished, in order to keep this vital channel free for emergency reports.

Training programs should be developed locally to ensure efficient operation of a Tornado Preparedness Plan. The cooperating National Weather Service official can assist with advice or in person, using training aids, as time permits. It is especially important that principals of all schools understand the Severe Local Storms Warning Service, and the value of supplemental spotters for schools, together with well-planned and practiced procedures and a special alarm signal for having school occupants take the best available cover when the school's spotter gives warning.

Operation of the Spotter Network

Spotters are alerted to the possibility of dangerous weather by the tornado and severe thunderstorm

Watches issued by the National Weather Service. Notification is by radio and television, law enforcement networks, or other designated channels. When a Watch is in effect, spotters should keep on the alert to notify the National Weather Service office or the Community Warning Center as soon as a tornado or severe thunderstorm is sighted, describing the type of storm, its location, intensity, and direction of movement. Even though a Watch has not been issued, spotters have to be constantly vigilant for severe weather whenever skies look threatening.

Each spotter who operates at a fixed point—home or office—is identified by a place name and a code number by the National Weather Service office to which he reports, for use as identification when calling in. The place name assigned to the observing point is usually that of the nearest community or some prominent geographic location. Mobile spotters such as law enforcement personnel or amateur radio operators with mobile equipment, indicate their position and the location of the observed tornado or severe thunderstorm by reference to a town, a crossroad, or some other well-identified point.

The National Weather Service office receiving the spotters' reports plots them, usually on its radar screen, which enables the radar operator to relate the reports to the radar "echoes" produced by the clouds accompanying the severe weather. By this means, the National Weather Service office can quickly determine the direction and rate of movement of the tornado or severe thunderstorm threat; call other spotters for confirming information; and determine which areas should be given immediate warning. This system is also used to follow the further progress of the storm cloud or clouds and to watch for additional tornadoes or severe thunderstorms—for sometimes more than one may plague an area at the same time, and, unless reports are continued and sorted out, confusion develops as to the location and direction of movement of the threatening condition.

Appreciation of Spotters' Efforts

The services performed by SKYWARN spotters have saved many lives. The National Weather Service attempts to acknowledge their performance by personal letters of thanks at the end of each season. Tornado Preparedness Committees may find that high morale can be maintained if a periodic newsletter is prepared under its auspices, and circulated to the members of the spotter network who are helping to protect the local community or area. The newsletter could contain discussions on instructions, questions and answers in reporting procedures, and summaries of recent severe local storm activity, listing those spotters who participated in reporting severe weather conditions.

Practice Drills

To make certain that the Tornado and Severe Thunderstorm Reporting Network becomes, or remains, functional, the Tornado Preparedness Committee should arrange for test exercises to be conducted during "safe" periods. All participants, the communications media, and the general public should be notified in advance of the practice nature of the exercise, so that there can be no confusion with an actual severe weather situation. Whenever possible, such drills should be held at times other than the usual storm season.

Special Supplemental Spotters

Mobile home groupings and suburban shopping centers can be particularly vulnerable to damage and destruction from tornadoes and severe thunderstorms, and require special attention. To the extent possible, each should arrange for supplemental spotters, identify a safe shelter, and train employees to use public address or other means to assist residents or shoppers to reach this shelter when a tornado or a severe thunderstorm approaches.

CHAPTER V—COMMUNICATIONS AND DISTRIBUTION OF WARNINGS

A comprehensive and reliable communications system is essential for dissemination of *Watches* and *Warnings* and for the exchange of information within the warning system. It should be a functional system, based upon existing communications channels and established on the principle of mass distribution through teletypewriter and radio communications. Its purposes are to:

a. provide the public with advance information that severe thunderstorms and tornadoes are likely;
b. provide progress reports concerning the development or lack of development of severe weather;
c. arrange to receive severe local storm reports from cooperative severe local storm observing and reporting networks;
d. distribute warning information to the areas toward which the tornado or severe thunderstorm is moving;
e. inform the public when the threat is over; and
f. provide backup communications.

Necessary Internal Communications Arrangements

A Warning Center is the focal point for the distribution and receipt of severe weather information for a specified area via established communications. Severe Thunderstorm and Tornado Watches and Warnings prepared by the National Weather Service are distributed from this center. It also receives reports of approaching tornadoes and severe thunderstorms from severe local storm spotters and issues local warnings. A local office of the National Weather Service may act as the Warning Center but any other establishment which has adequate communications, standby power facilities, and remains open around the clock would serve just as well.

In order to expedite the dissemination of Watches and Warnings to adjacent counties assigned to a National Weather Service office, each county could be assigned to an inter-county Warning Center. Inter-county Warning Centers, each responsible for four or five counties, are essential to a multi-county system. Warning Centers located in county seats at Civil Defense Warning Points and working closely with the National Weather Service would relay all messages to and from the counties assigned to those centers. Each county would have its own SKYWARN spotter network and county Warning Center. Many of the communities in each county also would have their own warning systems. If a tornado were sighted, the spotter would report the tornado to his county Warning Center, then would call the responsible National Weather Service office. This procedure would allow the county Warning Center to take appropriate warning actions for the community or communities immediately threatened, while providing the National Weather Service with the information needed to warn counties farther away but in the tornado's path. The county Warning Center would also send the report to the inter-county Warning Center over a special civil defense telephone system, if available. In addition to Warnings, the National Weather Service would furnish each inter-county Warning Center with severe weather Watches and frequent information on any severe weather in or approaching the counties assigned to the Center. At the county level, the county law enforcement agency would pass the warning to designated officials in the county and in each city.

Reaching the Public

Although the National Weather Service is responsible for warning the public of the sighting of tornadoes and severe thunderstorms, it has limited means of communicating Warnings directly to the public.

Instead, the National Weather Service relies on the public-spirited cooperation of the broadcast industry, composed of the AM, FM and TV station facilities, as the primary method for reaching as large a part of the general public as possible with Watches and Warnings of "short-fuse" hazards. Cooperation of the broadcast industry in this public service has been uniformly excellent, and many people owe their lives to it.

Surveys show that under emergency conditions, when the interest and concern of the public have been aroused, the broadcast industry has a potential listening and/or viewing audience of approximately 90 percent of the population involved.

However, it must be understood that participation of the broadcast industry in spreading information on severe weather conditions for the benefit of listeners and viewers is purely a matter of cooperation. Commercial broadcast stations (AM, FM, and TV) are not *required* by any government regulation to broadcast emergency weather Warnings. All weather Warnings are transmitted *at the option of the licensee*, who maintains control of the station facilities at all times.

Broadcast arrangements across the country take account of the greater transmissivity of radio waves during nighttime hour. Most AM radio stations operate only on a sunrise-to-sunset basis, going off the air at local sunset. However, a nucleus of almost 500 AM stations operates 24 hours daily. They have a relatively large listening audience and should be invited to participate in any warning program of communities in the areas they serve.

In some cases, there are "hot lines"—direct voice connections—between the National Weather Service office which originates warning, and the broadcast studio, permitting National Weather Service officials to broadcast directly ("live") to the listening public. In several areas, local broadcasters, with the encouragement of the Federal Communications Commission, have developed a plan whereby a key radio station alerts the other members of the system. The member stations, all on a voluntary basis, rebroadcast simultaneously the weather Warning that the key station carries. Under present rules and practices employed in the commercial broadcasting industry, it is entirely a local and independent determination when or whether to broadcast a natural disaster warning to the listening public—and the cooperation has been excellent.

In summary, the primary link between the National Weather Service office, which has the Watch and Warning responsibility, and the public is the broadcast industry which disseminates these Watches and Warnings.

Reaching the Broadcast Stations

Until recent years, local and partial-State teletypewriter circuits were operated by the National Weather Service for warning purposes and to disseminate weather information. In a number of States, such facilities have been replaced by statewide, intrastate NOAA Weather Wire circiuts. The National Weather Service pays to have the circuits run to every community of appreciable size in the State. Newspapers, radio and television stations, and others interested can have receivers on these circuits for a moderate connection and monthly service charge. These NOAA Weather Wire circuits have increased the ability of the National Weather Service to transmit urgent Warnings to radio and television stations serving communities in the path of any severe weather. In some States the National Weather Service can activate positive alerting devices which call the immediate attention of station personnel to the urgency of the message so that it can be broadcast immediately. Other Severe Weather Statements, detailing the progress of the severe weather situation, continue to follow until an All-Clear bulletin from the responsible National Weather Service official signals an end to the threat.

In States which do not yet have the NOAA Weather Wire (which is being implemented progressively as funds become available) the local teletypewriter loops continue to be a major means of quick communication between the National Weather Service and the broadcast media and press wire service. The press wire services then relay important messages to their subscribers.

Other Means

Besides the statewide teletypewriter circuits and the assistance of the broadcast industry, the National Weather Service uses a number of methods to transmit Warnings rapidly to key people at warning points in small communities. For example, a telephone call may be made to other facilities capable of using their internal communications systems to relay Warnings to affected communities where sirens, loud speakers, and other means are employed to reach the public immediately.

Similarly, urgent messages are passed along to law

enforcement agencies (local, county, and State) and Civil Defense units (frequently over a special Civil Defense-operated intrastate telephone network which connects Civil Defense Warning Points within each State).

At a few locations (limited at present mostly to coastal points in the eastern and southeastern States) the National Weather Service operates a weather warning system by means of its continuous weather transmission facilities—on FM frequencies of 162.40 and 162.55 MegaHertz. Individuals and agencies having suitable receivers may obtain adequate warning of tornadoes or severe thunderstorms by this means. The equipment has a special tone-emitting capability to activate suitably equipped muted radio receivers in schools, hospitals, government offices, factories and other establishments within a transmitting range of about 50 miles (line of sight).

For standby facilities, in case normal communications are disrupted during a severe weather situation most National Weather Service offices depend on the cooperation of law enforcement agencies, civil defense, or amateur radio equipment, either backed by emergency power generators or safe from disruption because of its mobile character.

Audible Warnings

By the various means described National Weather Service Watches and Warnings can be transmitted to almost any point in an area of county responsibility. There still remains the problem of warning people directly who may not be listening to a broadcast but are threatened by the immediate approach of severe weather. Warnings have been spread directly to the people on the street by individuals having access to two-way mobile radios (amateur radio operators or law enforcement officers). They have frequently endangered their lives to do this.

A steady-tone signal of three to five minutes duration over Civil Defense sirens may be used, at local option, as an attention-getting signal for natural disaster situations, or for other uses chosen locally. When this is used, persons should tune to radio and television stations to learn what and where the danger is.

In rural communities, the party telephone sometimes can be used to sound a general alarm. Church bells and fire whistles are also available for sounding the alarm.

The American Red Cross participates in the public education program by making available through local chapters it's color film "Tornado Disaster Action", a four and one-half minute film issued in March 1968 which can be used by television stations in connection with tornado watch and severe thunderstorm watch announcements. In addition the Red Cross periodicially runs tornado safety material in it's Red Cross Youth magazine and cooperatively with NOAA reproduces and distributes in quantity with Red Cross imprint the various NOAA tornado safety materials. This information is also made available to local Red Cross chapters for use in all kinds of publications, leaflets, and posters. The Red Cross also, through it's Disaster Preparedness Program, works with all kinds of local organizations and local offices of the National Weather Service to cooperate in tornado preparedness as well as other disaster preparedness efforts. Information about the local Red Cross disaster program can be obtained from local chapters and can easily be added to different National Weather Service materials. In many instances the Red Cross will produce mailing enclosures for use in NOAA material and naming the Red Cross and the National Weather Service as it's source.

CHAPTER VI—PUBLIC EDUCATION ON TORNADOES AND SEVERE THUNDERSTORMS

The National Weather Service of NOAA has brochures, movies, and speakers to carry to the public the message of the danger of tornadoes and severe thunderstorms and what action to take when they threaten. The SKYWARN tornado preparedness program, begun in January 1969, strengthens spotter recruitment, SKYWARN volunteers' identity, and public awarness of tornado hazards through publications, articles, and institutional ads in cooperating newspapers. Prints of the color film "TORNADO!" are available at moderate expense to school, libraries, Civil Defense Offices, and others. National Weather Service officials will provide copies of the brochures at your Tornado Preparedness Meeting and arrange for a showing of the film. Additional supplies of publications dealing with tornadoes and safety precautions are available for distribution at cost. Please apply to National Weather Service Regional Headquarters, or to the NOAA Public Information Office, listed in Chapter I, Table 1, for information on how to obtain these aids.

Several years may pass, at times, without a threat to a particular locality. This results in public complacency and apathy with regard to maintaining awareness of safety measures to be taken during severe weather outbreaks. Also, with our shifting population, newcomers to an area need education on severe local storms, on the warning system, and on shelter possibilities.

Complacency may also increase if several Tornado or Severe Thunderstorm Watches have been issued but the immediate local area does not experience severe weather. This is often the case. It is rare that a particular Watch area is affected by severe weather over more than a small percentage of its area even though the potential danger actually exists throughout the area during the period of threat.

The Tornado Preparedness Committee (through the Subcommittee on Public Education) should arrange a program of repeated emphasis (with greatest concentration just prior to the tornado season) on its Tornado Preparedness Plan and on the measures that people should keep in mind for their personal safety. The mention of any imminent severe weather in routine weather forecasts provides propitious means to alert people who know how the Tornado Preparedness Plan works—how Watch bulletins and Warning bulletins are disseminated, and what the safety rules are—to get ready to act if the need arises. Since severe thunderstorms, which occur far more frequently than tornadoes, are handled by this same Plan, the Tornado Preparedness Committee has the occasional opportunity to refresh the public's education, understanding, and safety practices between rare tornado occurrences.

Recommended safety rules and pre-season actions, together with safety rules on lightning, appear at the end of this Chapter.

This program of repeated emphasis should aim at developing a public attitude of confidence in the local Tornado Preparedness Plan; informed caution during periods of Tornado Watch or Severe Thunderstorm Watch; and, above all, readiness to be prepared to take immediate cover for protection whenever a WARNING is issued. It should also stress the characteristics and danger of severe weather hazards, the terminology to be used to alert and warn the public and where to obtain authentic information.

With the advice of the cooperating National Weather Service official, workshops and seminars should be arranged for local groups by the Tornado Preparedness Committee. It is especially important that heads of various types of schools within the area, and students as well, receive briefings on the importance of supplemental spotters for their buildings, selection of shelter areas, distinctive severe weather warning signals within the buildings, and

drills to prepare for movement to safety areas when a tornado or severe thunderstorm approaches.

IMPORTANT: The effectiveness of any preparedness program depends upon the ability of all individuals to take immediate measures for their own protection. The Tornado Preparedness Committee will find it beneficial to organize public participation in off-season practice drills, fully announced well in advance. Public and private schools, colleges, hospitals, industrial plants, churches, sports arenas, and other facilities for public assembly should conduct practice sessions at least once each year. Schools should have practice severe storm drills in much the same manner as for practice fire drills. Distinctive tornado alarm signals should be used so people will know what to do or where to go when an actual Tornado or Severe Thunderstorm Warning is issued.

Newspapers, radio stations, and television stations have cooperated in arranging for articles and programs at the beginning of the local severe weather seasons, stressing public education in protective measures against natural hazards and in using taped messages (furnished by the National Weather Service) following special announcements of Tornado and Severe Thunderstorm Watch and Warning Bulletins. Interviews with Tornado Preparedness Committee members and National Weather Service officials have also been presented. Newspaper publication of SKYWARN ads, safety rules, the meaning of the terms "Watch," "Warning," and "All-Clear," and the nature of local Tornado Preparedness Plans has greatly increased public awareness in many communities.

RECOMMENDED SAFETY RULES AND PRE-SEASON ACTIONS

Tornado Safety Rules	PRE-SEASON ACTIONS
Shelter—Seek inside shelter if possible. If in the open, move away from a tornado's path at a right angle. If there is no time to escape, lie flat in the nearest depression, such as a ditch or ravine.	
In office buildings, the basement or an interior hallway on a lower floor is safest. Upper stories are unsafe. If there is no time to descend, a closet or small room with stout walls, or an inside hallway will give some protection against flying debris. Otherwise, under heavy furniture must do.	Shelter areas should be selected and marked, and building employees should be trained to direct the occupants to them.
In homes with basements, seek refuge near the basement wall in the most sheltered and deepest below ground part of the basement. Additional protection is afforded by taking cover under heavy furniture or a workbench. Other basement possibilities are the smallest room with stout walls, or under a stairway.	A storm cellar, or a reinforced portion of the basement can be planned and constructed; or the safest portion of the basement can be selected and the family drilled to use it.
In homes without basements take cover in the smallest room with stout walls, or under heavy furniture, or a tipped-over upholstered couch or chair in the center part of the house. The first floor is safer than the second (or third). If there is time, open windows partly on the side away from the direction of the storm's approach — *but stay away from windows when the storm strikes.*	Construction of a storm cellar is particularly advisable for homes without basements. An alternative is preseason selection of a nearby culvert or deep ditch.
Mobile homes are particularly vulnerable to overturning and destruction during strong winds, and should be abandoned in favor of a preselected shelter, or even a ditch in the open. Damage can be minimized by securing the trailer with cables anchored in concrete footing.	If permission can be obtained to use a nearby basement, a well-constructed utility building, or other nearby shelter, mobile-home park occupants should select a leader responsible for ensuring constant radio monitoring and supplemental storm spotting, and for sounding the alarm if a storm approaches.
Factories, auditoriums, and other large buildings with wide, free-span roofs, should have preselected, marked shelter areas in their basements, smaller rooms, or nearby.	Shelter areas should be selected and marked, and building employees should be trained to direct occupants to them. Supplemental spotters should watch for storms and give warning; drills should be held before and during season.

Personal preparations should include availability of a battery-operated radio, in case of power loss; knowledge of safety rules and how to tell if a tornado or severe thunderstorm is approaching; and change of family plans in order to remain near shelter during a severe local storm threat.

Parked cars are unsafe as shelter during a tornado or severe windstorm; however, as a last resort, if no ravine or ditch is nearby they may provide some shelter from flying debris to those who crawl under them.

Study safety rules, select shelter area in home, provide extra batteries for small radio, learn the siren or other local immediate warning signal for your community, and learn how to identify an approaching tornado or severe thunderstorm.

Special Safety Rules and Pre-Season Actions for Schools

1. The school system or group should develop a plan for internal dissemination of Watches and Warnings of tornadoes and severe thunderstorms, based on assignment of a key person and alternate(s) supplied with a communications channel or emergency telephone numbers to key persons in all facilities.
2. All facilities should be inspected, and shelter areas selected and marked.
3. Special "tornado alarm" signals should be established to warn all occupants of the facilities. A secondary system should be available in case of power failure before a storm strikes.
4. A system of supplemental tornado/severe thunderstorm spotters (teachers, administrative or maintenance employees, or reliable students) should be established, ready for activation whenever a Watch or Warning is announced or when severe weather conditions appear to be approaching the area.
5. Procedures should be established in each facility for monitoring of radio and television receivers for additional severe weather information during threats.
6. Procedures should be established for use or non-use of school buses during conditions of *Watch* and *Warning;* and drivers should be drilled in measures to be taken to provide for occupants to take cover in a shelter, ditch, or ravine if the bus is caught in the open by a severe storm.
7. Pre-season and periodic in-season severe weather drills should be held at all facilities to ensure that staff and students will all respond properly when an actual tornado or severe thunderstorm approaches the facility.
8. Plans should be made to protect participants and those in group attendance at affairs such as sporting events (in gymnasiums or in the open) or school plays by reliable supplemental spotters, ample advance warning, and dismissal with take-shelter instructions if any danger appears imminent. Gymnasiums and auditoriums with wide-span roofs are unsafe in such situations. To the extent possible, plans should be made to shelter as many people as possible in safe areas, such as in passage tunnels or under solid stands of playing fields, basements or inner hallways of buildings, and otherwise as indicated under general safety rules.

Lightning Safety Rules

When indoors, and lightning threatens:

1. Stay indoors, and don't venture outside unless absolutely necessary.
2. Stay away from open doors or windows, fireplaces, radiators, stoves, metal pipes, sinks, and plug-in electrical equipment like radios, television sets, lamps, and refrigerators.
3. Don't use plug-in electrical equipment like hair driers, electric toothbrushes, or electric razors during an electrical storm.
4. Don't use the telephone—lightning may strike the telephone lines outside.

When outdoors, during a lightning storm:

1. Don't work on fences, telephone or power lines, pipelines, or structural steel fabrication.
2. Don't use metal objects, like fishing rods and golf clubs.
3. Don't handle flammable material in open containers.
4. Stop tractor work, especially when the tractor is pulling metal equipment. Dismount and move away. Tractors in open fields are often struck by lightning.
5. Get out of the water and off small boats. Stay "indoors" in large boats.
6. Automobiles offer excellent lightning protection, but they are unsafe places when a tornado or severe thunderstorm approaches, with

strong winds, due to possibility of destruction by the winds.

7. Seek shelter from lightning in a building; otherwise, in a cave, ditch, ravine, or under head-high (at least) clumps of growth in open forest glades.
8. When there is no shelter, avoid the highest object in the area (and avoid *being* the highest object). If only isolated trees are nearby, your best protection is to crouch or lie in the open, keeping at least as far away from isolated trees as they are high.
9. If you have metal on your costume, such as golf spikes, get rid of it—you may be grounded and attract lightning strongly.
10. Avoid hilltops, wire fences, metal clotheslines, exposed sheds, and any electrically conductive elevated objects.
11. When you feel the electrical charge—if your hair stands on end or your skin tingles—lightning may be about to strike you. Drop to the ground immediately.

CHAPTER VII—MEDICAL AND HOSPITAL TORNADO AND SEVERE THUNDERSTORM PLANS

Presumably, medical and hospital readiness for disaster is well-organized and hospitals in each area have plans to back each other up in case of an overload of injured following a disaster, or in case one is badly damaged by a tornado or severe thunderstorm.

Through arrangements in the Tornado Preparedness Plan, each hospital should be alerted each time a Tornado Watch or a Severe Thunderstorm Watch is issued for the area; and should be immediately notified whenever a Tornado Warning or a Severe Thunderstorm Warning is issued that might result in a need for ambulances, doctors, and nurses.

Usual provisions will have been made to call in doctors, interns, nurses, and nurses' aids for emergency service via a posted telephone list; and for augmentation of the hospital switchboard staff.

Through the efforts of the medical association or of the Tornado Preparedness Committee, all doctors and nurses should have in their possession at all times special passes and windshield identification that allow them to pass immediately through law enforcement agency roadblocks on their way to assist at disaster sites.

During Watch periods, it should be a definite duty to ensure that ambulances are ready with all necessary equipment, and that suitable staff is ready to man them immediately.

To protect the hospitals themselves, trained supplemental spotters should be posted outdoors to maintain continuous watch for the approach of a tornado or a severe thunderstorm. Preferably, they should be able to communicate immediately with a person indoors who can announce an imminent strike of a tornado or severe thunderstorm over the public-address system of the hospital.

Since electric power and communications will be all-important to the hospital in the hours following a disaster, it is assumed that standby emergency power generation facilities would be in readiness. Emergency two-way radio communications may become necessary, and may be supplied through the cooperation of a law enforcement agency, an amateur radio group, or others.

As in the case of schools, hospitals should plan to do what can be done to protect patients, visitors, and hospital personnel if a tornado strikes the hospital. Employees should be drilled in emergency procedures. Shelter areas (usually lower floors and inside corridors, as well as bathrooms with their shielding walls) should be selected to protect from flying glass and other debris, and hospital personnel should be trained to know which areas are best. If there is time before a tornado strikes, provision should be made to block beds, at least in outer rooms, to keep them from being rolled by strong winds. Some protection against flying debris may be afforded by shielding bedfast patients with thick blankets and by moving their beds to the inside walls of their rooms. If little time is available to take cover, patients may take refuge in closets, or underneath their beds.

It would be inadvisable to use elevators just before a tornado strikes because of probable power failure and possible wreckage of the cable penthouse.

CHAPTER VIII—POST-DISASTER RELIEF AND REHABILITATION

Many areas and communities already have a general Disaster Plan which covers the range of requirements. Chapter 12 of "The Vice President's Handbook for Local Officials" (Nov. 1967) details the types of assistance available under the Federal Disaster Relief Program, which is administered by the Office of Emergency Preparedness. It also includes a summary of the types of assistance available from other sources.

Complete and detailed information should be obtained by the Tornado Preparedness Committee concerning the ready assistance that can be made available to the local community or area in a post-disaster situation.

Representatives of the Civil Defense organization are well versed in these matters, as are local Red Cross Chapter officials. Additional information can be secured from similar functionaries at the county, State, and national level.

A suitable subcommittee should review and digest all such information for the Tornado Preparedness Committee, and condense it for inclusion in the local Tornado Preparedness Plan.

Especially important would be the description of actions to be taken immediately after a disaster, as indicated in Chapter III, together with the addresses and telephone numbers of persons or agencies to be contacted.

CHAPTER IX—SEVERE LOCAL STORMS WARNING SERVICE

An understanding of the functions, operation, and capabilities of the severe local storm warning service provided to the public by NOAA's National Weather Service will be helpful to any community or individual interested in planning protection against these storms. This Commerce Department service has four main functions:

1. The collection and analysis of existing weather conditions (such as surface and upper air observations, and thunderstorm reports) to determine if severe weather (tornadoes or severe thunderstorms) is likely;
2. The issuance of Watches and Warnings;
3. The distribution of Watches, Severe Weather Statements, Warnings and All-Clears to the public so it will know what course of action to take; and
4. Public education on tornadoes and severe thunderstorms.

A specialized office, the National Severe Storms Forecast Center (NSSFC) is located at Kansas City, Missouri. All bulletins announcing Tornado *Watches* and Severe Thunderstorm *Watches* originate in the NSSFC. Experienced meteorologists constantly analyze atmospheric conditions over the 48 conterminous States in order to detect those areas where severe thunderstorms or tornadoes are likely to occur. Also, when there is an occurrence, a special analysis is immediately made to determine whether additional occurrences can be expected or whether the threat is a marginal one and can be expected to decrease. Due to various data restriction along with the limitations in our current knowledge of the cause of such storms, it is not possible to predict the exact time of formation of tornadoes, or severe thunderstorms, or exactly where they will strike. Present severe local storm forecasting techniques are aimed at predicting the areas (usually about 120 by 250 miles in size) which are expected to contain the maximum amount of severe weather. Thus, each *Watch* area is surrounded by an area having an expected lower probability of occurrences with the probability of such occurrences decreasing with distance from the predicted area. The average lead time (time interval between time of issuance by NSSFC and beginning of valid period) of Tornado and Severe Thunderstorm Watches is one hour. On occasion it is possible to give a lead time of three to four hours. The valid time (time interval during which the National Weather Service thinks the average weather will occur) of the Watch is usually six hours.

Public Severe Weather Watches released from the National Severe Storms Forecast Center are two types—Severe Thunderstorm and/or Tornado Watch. Examples are given at the end of this Chapter.

These public Severe Weather Watches are transmitted by internal National Weather Service and other meteorological communications circuits to local offices with county responsibility in the Watch areas specified in the bulletins. For Severe Weather Watch dissemination and warning purposes, each county in the United States is assigned to a nearby National Weather Service office. These blocks of counties are referred to as county warning areas. The bulletins are also released by the NSSFC to the news wire services. Entered on the press wires, they quickly reach subscribers—newspapers, radio stations, and television stations—serving the Watch area.

Normally, the bulletins are broadcast in a matter of a few minutes. They define watch areas *in general terms of sections of States*. The period of time covered by the *Watch*—the "valid period"—is included, as well as advice to be on the watch for local weather developments and for later weather statements and warnings.

Responsible local offices of the National Weather Service upon receipt of *Watch* bulletins via meteoro-

logical circuits, immediately prepare and issue a redefining statement or "areal outline." Redefining statements are more detailed designations of the parts of the States specified in the public Severe Weather Watch as likely to be affected by severe thunderstorms or tornadoes *in terms of whole counties, towns or well-known geographical landmarks.*

Local offices of the National Weather Service are responsible for arranging for the dissemination of messages dealing with severe weather information throughout their assigned county warning areas. Various communications arrangements are made. In States already served by NOAA Weather Wire, that channel is used, and on some circuits the National Weather Service can energize a positive alerting device to direct attention to the important bulletin on the teletypewriter receiver.

In addition to, or in the absence of, the NOAA Weather Wire, other methods used for rapid dissemination include local teletypewriter circuits, telephone, cooperating law enforcement and civil defense communications networks, and special "hot-line" communications. By any or all of these means, the National Weather Service office alerts and keeps informed the cooperating newspapers, radio and television stations, law enforcement agencies, civil defense units, hospitals, spotters, school system headquarters, and others. Many of the recipients provide further dissemination, by broadcast, transmission over agency communications networks, or by telephone.

The issuance of a *Tornado Watch* for a specific area should not be construed as indicating that no tornadoes will occur outside of that area. It is emphasized that the *Watch* designates the area in which tornadoes are most likely to occur. The *Watch* areas are purposely kept as small as practicable in order to avoid needlessly alerting the residents of an unduly large area, but those in counties adjacent to *Tornado Watch* areas should maintain at least a casual watch on local weather developments.

The other type of public severe weather release by NSSFC is a *Severe Thunderstorm Watch.* A thunderstorm is considered to be "severe" if it contains either damaging winds (surface wind gusts greater than 75 miles per hour) or hailstones at least ¾ inch in diameter at the surface of the ground, or both. If one or more tornadoes are expected to be generated by the severe thunderstorms, a *Tornado Watch* is issued rather than a *Severe Thunderstorm Watch;* and *Tornado Watch* bulletins always state that severe thunderstorm activity is also expected.

In the majority of instances, tornadoes do not occur in areas covered by a Severe Thunderstorm Watch, but in borderline cases it becomes difficult or impossible to ascertain precisely whether the severe weather will be in the form of severe thunderstorms or tornadoes. For this reasons, and because severe thunderstorms are in themselves capable of doing considerable damage to heavily populated areas, all severe weather releases deserve careful attention.

A Tornado or Severe Thunderstorm Warning is issued when a tornado or severe thunderstorm has actually been sighted in the area (usually by a severe weather spotter) or indicated by radar. Persons near, and especially in the direction of travel of the severe weather as stated in the *Warning*, should take immediate cover if they are quite close, or be prepared to take immediate cover if they are farther away from the reported current location, but in the line of direction of movement. In many cases, Warnings are made possible through the cooperation of public-spirited persons who notify the nearest office of the National Weather Service or community Warning Center when a tornado or severe thunderstorm is sighted. Warnings are issued immediately by the responsible office and indicate the location of the tornado or severe thunderstorm at the time of detection, the area (usually counties) through which it is expected to move, and the time period (usually one hour) during which it will move through the area warned. The length of the area warned is equal to the distance the tornado is expected to travel in one hour. *Examples of Watches, Warnings, and Severe Weather Statements are given at the end of this Chapter.*

Severe Weather Statements are distributed by local offices of the National Weather Service to keep the public fully informed of all current information, especially when a Watch or Warning bulletin has been issued. Statements are issued at least once each hour, and at more frequent intervals when severe weather develops or changes rapidly.

In this way, close watch is kept on weather developments, and information on the current situation, including rapid Warnings when necessary, is disseminated to the counties for which the local office of the National Weather Service is responsible. This alerts them to prepare for the worst, or informs them as soon as possible of the end of the threat.

In order that the public in a Watch area may resume normal activities as soon as possible, local officers disseminate All-Clear bulletins as soon as advisable, informing a part or all of their county warning areas that the threat of severe weather no

longer applies. *By this means successive areas, or one or more counties within one area, can be released successively, while a Watch or Warning remains valid for the remainder, and for adjacent areas toward which severe weather is still moving.*

The term "bulletin" is used in the heading of severe weather Watches, Warnings and All-Clears. It indicates an urgent message affecting public safety, and receives preferential and more expeditious handling by news media and other users.

Examples

1. *TORNADO WATCH BULLETIN* NUMBER 23
   ISSUED 4 PM CST MARCH 2, 1967
   THE [NATIONAL WEATHER SERVICE] HAS ISSUED A TORNADO WATCH FOR . . .
   PORTIONS OF EASTERN LOUISIANA
   A PORTION OF WEST CENTRAL ALABAMA AND MOST OF MISSISSIPPI
   THE THREAT OF TORNADOES WILL EXIST IN THESE AREAS FROM 5 PM UNTIL 11 PM CST THIS THURSDAY EVENING. SCATTERED SEVERE THUNDERSTORMS WITH LARGE HAIL AND LOCALLY DAMAGING WINDS ARE ALSO FORECAST.
   THE GREATEST THREAT OF TORNADOES AND SEVERE THUNDERSTORMS IS IN AN AREA ALONG AND 60 MILES EITHER SIDE OF A LINE FROM BATON ROUGE LOUISIANA TO TUPELO MISSISSIPPI.
   PERSONS IN OR CLOSE TO THE TORNADO WATCH AREA ARE ADVISED TO BE ON THE WATCH FOR LOCAL WEATHER DEVELOPMENTS AND FOR LATER WEATHER STATEMENTS AND WARNINGS.
   THIS WATCH INCLUDES THE COUNTIES OF . . .
   (or the geographical area bounded by . . .)

2. *SEVERE THUNDERSTORM WATCH BULLETIN* NUMBER 19
   ISSUED 3:40 PM CST MARCH 4, 1967
   THE [NATIONAL WEATHER SERVICE] ISSUED A SEVERE THUNDERSTORM WATCH FOR . . .
   PORTIONS OF CENTRAL OKLAHOMA AND
   A PORTION OF SOUTH CENTRAL KANSAS
   THE THREAT OF ONE OR TWO ISOLATED SEVERE THUNDERSTORMS WITH LARGE HAIL AND DAMAGING WINDS WILL EXIST IN THESE AREAS FROM 6:00 PM UNTIL MIDNIGHT CST THIS SATURDAY EVENING.
   THE SEVERE THUNDERSTORMS ARE EXPECTED IN AN AREA ALONG AND 60 MILES EITHER SIDE OF A LINE FROM 40 MILES EAST OF WICHITA KANSAS TO 20 MILES SOUTH OF ARDMORE OKLAHOMA.
   PERSONS IN OR CLOSE TO THE SEVERE THUNDERSTORM WATCH AREA ARE ADVISED TO BE ON THE WATCH FOR LOCAL WEATHER DEVELOPMENTS AND FOR LATER STATEMENTS AND WARNINGS.
   THIS WATCH INCLUDES THE COUNTIES OF . . .
   (or the geographical area bounded by . . .)

3. *TORNADO WARNING BULLETIN*
   EANS (EMERGENCY ACTION NOTIFICATION SIGNAL) REQUESTED
   [NATIONAL WEATHER SERVICE] OKLAHOMA CITY OKLAHOMA
   ISSUED 4:00 PM CDT APRIL 30, 1967
   A TORNADO WARNING IS IN EFFECT UNTIL 5:00 PM FOR PERSONS IN COTTON AND COMANCHE COUNTIES.
   A TORNADO WAS REPORTED BY THE PUBLIC 7 MILES EAST OF GRANDFIELD OKLAHOMA AT 3:55 PM. THIS TORNADO IS MOVING TOWARD THE NORTHEAST AT 30 MPH.
   IF A TORNADO IS SIGHTED OR THREATENING CONDITIONS ARE SIGHTED . . . BE PREPARED TO MOVE TO A PLACE OF SAFETY. TO REPORT A TORNADO PLACE AN EMERGENCY COLLECT CALL TO THE OKLAHOMA CITY WEATHER [SERVICE OFFICE] OR CALL THE NEAREST LAW ENFORCEMENT AGENCY.

4. *SEVERE THUNDERSTORM WARNING BULLETIN*
   EANS REQUESTED
   [NATIONAL WEATHER SERVICE] WICHITA KANSAS
   ISSUED 4:40 PM CDT MAY 10, 1967
   A SEVERE THUNDERSTORM WARNING IS IN EFFECT UNTIL 5:30 PM FOR PERSONS IN BUTLER, COWLEY, ELK AND GREENWOOD COUNTIES.
   A LINE OF THUNDERSTORMS WAS INDICATED BY RADAR FROM WELLINGTON TO AUGUSTA AT 4:35 PM. THE LINE OF THUNDERSTORMS IS MOVING TOWARD THE NORTHEAST. AT 4:35 PM WELLINGTON, KANSAS REPORTED 70 MPH WINDS AND 1 INCH HAIL.
   BE PREPARED TO MOVE TO A PLACE OF SAFETY IF HAIL OR THREATENING CONDITIONS ARE SIGHTED TO REPORT LARGE HAIL OR DAMAGING WINDS . . . PLACE AN EMERGENCY COLLECT CALL TO THE WICHITA KANSAS WEATHER [SERVICE OFFICE] OR CALL THE NEAREST LAW ENFORCEMENT AGENCY.

5. *SEVERE WEATHER STATEMENT*
   [NATIONAL WEATHER SERVICE] BIRMINGHAM ALABAMA
   ISSUED 4 PM CST JANUARY 20, 1967
   NO TORNADOES HAVE BEEN REPORTED IN NORTHERN ALABAMA UP TO 4 PM. IT IS STILL POSSIBLE FOR A FEW TORNADOES TO DEVELOP IN PARTS OF NORTHERN ALABAMA UNTIL 6 PM. KEEP TUNED TO YOUR RADIO OR TELEVISION STATION FOR LATER INFORMATION. BE PREPARED TO TAKE SAFE SHELTER IF A WARNING IS ISSUED FOR YOUR LOCALITY OR IF THE SKY BECOMES UNUSUALLY THREATENING.

6. *SEVERE WEATHER STATEMENT*
   [NATIONAL WEATHER SERVICE] PEORIA ILLINOIS

ISSUED 2 PM CST JUNE 14, 1966
THUNDERSTORMS ARE STARTING TO DEVELOP NEAR PEORIA ILLINOIS AT 2 PM. THIS IS THE ONLY NEW DEVELOPMENT REPORTED SO FAR IN CENTRAL ILLINOIS WHERE A FEW SEVERE THUNDERSTORMS WITH DAMAGING WINDS ARE POSSIBLE UNTIL 6 PM. KEEP TUNED TO YOUR RADIO OR TELEVISION STATION FOR LATER INFORMATION.

7. *SEVERE WEATHER STATEMENT*
IMMEDIATE BROADCAST REQUESTED (when appropriate)
[NATIONAL WEATHER SERVICE] OKLAHOMA CITY OKLAHOMA
ISSUED 3:55 PM CST APRIL 13, 1966
DURING THE PAST 15 MINUTES THUNDERSTORMS ALONG A LINE WHICH EXTENDS FROM ENID THROUGH CLINTON TO ALTUS HAVE BEEN AND STILL ARE INCREASING RAPIDLY IN INTENSITY. AT 3:45 PM THE HIGHWAY PATROL AT CLINTON REPORTED WINDS OF 45 MPH AND ½ INCH HAIL. THIS LINE OF THUNDERSTORMS IS MOVING SOUTHEAST AT 30 MPH. PERSONS IN THE AREA ALONG AND 30 MILES SOUTHEAST OF THIS LINE SHOULD BE ALERT TO THE POSSIBILITY OF DAMAGING WINDS AND HAIL UNTIL 5 PM. BE PREPARED TO TAKE SAFE SHELTER IF A WARNING IS ISSUED FOR YOUR LOCALITY OR IF THE SKY BECOMES UNUSUALLY THREATENING.

(Note: When these messages were issued the National Weather Service was the U.S. Weather Bureau, which became the National Weather Service of the U.S. Commerce Department's National Oceanic and Atmospheric Administration in October 1970.)

CHAPTER X—DESCRIPTION AND CLIMATOLOGY OF TORNADOES AND SEVERE THUNDERSTORMS

The importance of the geographic, seasonal and diurnal distribution of tornado occurrences must be considered in community tornado preparedness planning. Any plan developed should take into account the risk in a particular area. Tornadoes occur in many parts of the world and in all 50 States, but no area is more favorable to their formation than the continental plains of the United States (see Figure 1) and no season is free of them. Normally, the number of tornadoes is at its lowest in the United States during December and January, and at its peak in May (see Figure 4). The months of greatest total frequency are April, May, and June.

In February, when tornado danger begins to increase, the center of maximum frequency lies over the central Gulf States. Then, during March, this center moves eastward to the southeast Atlantic States, where tornado frequency reaches a peak in April. During May, the center of maximum frequency moves to the southern plains States and, in June, northward to the northern plains and the Great Lakes areas as far east as western New York State. The reason for this drift is the increasing penetration of warm, moist air from the south while contrasting cool, dry air still surges in from the north and northwest. Tornadoes are generated with the greatest frequency along the boundary between these air masses. Thus, when the Gulf States are blanketed by warm air and there is no cold air intrusion to speak of, the tornado frequency drops. This is the general situation across the Nation after June. However, tornadoes may also be generated in connection with hurricanes. Winter cooling permits fewer and fewer encounters between warm and cold air, and tornado frequency reaches its lowest level in December.

During the period 1953–1969, an average of 642 tornadoes a year occurred in the United States, about half of them during three months—April, May and June. Although records have been kept for a longer period, the 1953–1969 period is more representative since it coincides with increased public awareness of tornadoes and the development of the tornado forecasting service. For the same period, the annual average number of tornado days (days with one or more tornadoes) was 159. Average annual frequency by State for this period (without regard to size of State) ranges from 103 tornadoes in Texas to less than three in most of the northeastern and far western States and less than one in Oregon and Nevada. In 1967, 912 tornadoes were reported, constituting an all-time high. Texas, Oklahoma and Kansas experienced the greatest number of these storms.

Characteristics of Tornadoes

A Tornado is a violently rotating column of air pendant from a thunderstorm cloud and *touching* the ground. It nearly always starts as funnel-shaped rotating extrusion from the thunderstorm cloud, builds downward to the ground, and darkens as it picks up debris. On a local scale it is the most destructive of all atmospheric phenomena.

Tornadoes form several thousand feet above the earth's surface, usually during warm, humid, unsettled weather, and usually in conjunction with a severe thunderstorm. Sometimes a severe squall line many miles long may contain a number of tornado-producing thunderstorms.

Sometimes a series of two or more tornadoes is associated with a parent thunderstorm (and there have been a number of times when two tornadoes have occurred simultaneously, pendant from the same thunderstorm). As the parent thunderstorm moves along, tornadoes may form, travel along in touch with the ground for a few miles, dissipate or lift, and then touch down again—sometimes several times.

Because one or more tornadoes may develop in a

given situation from one or more thunderstorm clouds, and their period of contact with the ground may be short, prolonged, or intermittent, Watches and Warnings of tornadoes and severe thunderstorms must be issued on an area basis, rather than for a particular location.

Knowledge of the following general characteristics of tornadoes is useful in tornado preparedness planning and to individuals:

TIME OF DAY during which tornadoes are most likely to occur is mid-afternoon, generally between 3 and 7 p.m., but they have occurred at all times of day.

DIRECTION OF MOVEMENT is usually from southwest to northeast. (Note: Tornadoes associated with hurricanes may move from an easterly direction.)

LENGTH OF PATH averages 4 miles, but may reach 300 miles. A tornado traveled 293 miles across Illinois and Indiana on May 26, 1917, and lasted 7 hours and 20 minutes.

WIDTH OF PATH averages about 300 to 400 yards but tornadoes have cut swaths a mile and more in width.

SPEED OF TRAVEL averages from 25 to 40 miles per hour, but speeds ranging from stationary to 68 miles per hour have been reported.

THE CLOUD directly associated with a tornado is a dark, heavy cumulonimbus (the familiar thunderstorm cloud) from which a whirling funnel-shaped pendant extends *to* the ground.

PRECIPITATION associated with the tornado usually occurs first as rain just preceding the storm, frequently with hail, and as a heavy downpour immediately to the left of the tornado's path.

SOUND occurring during a tornado has been described as a roaring, rushing noise, closely approximating that made by a train speeding through a tunnel or over a trestle, or the roar of many airplanes.

The Work of Winds and Pressure

The destructive power of a tornado is due to the combined action of its strong rotary winds and the partial vacuum in the center of its vortex. As a tornado passes over a building, the winds twist and rip at the outside at the same time that the abrupt pr sure reduction in the tornado's "eye" causes explosive over-pressures inside the building. Walls collapse or topple outward, windows explode, and debris of this destruction is driven through the air in a dangerous barrage. Heavy objects like machinery and railroad cars have been lifted and carried for considerable distances.

Wind Speeds

Vertical and horizontal wind speeds within the vortex of a tornado have never been measured directly by instruments exposed in the tornado funnel. Invariably, the instruments are destroyed by the storm. Engineering studies of tornado damage show that the horizontal wind speed in the center of a tornado may be more than 300 miles per hour. The wind speed diminishes rapidly away from the funnel and is relatively light just a few feet from the area of destruction.

The Casualty and Damage Potential. .

The greatest potential for casualties from tornadoes is not necessarily where the greatest number of tornadoes occurs, but where there is a combination of high tornado incidence and a dense concentration of population. For example, the greatest number of tornadoes, per 10,000 square miles, occurs in Oklahoma (Figure 1) and Texas has had more tornado caused deaths than any other State (Figure 2). Because of population density, the tornado threat is greatest in Massachusetts (Figure 3). All communities in the Midwest, Great Plains and the southeastern States, regardless of size, and many populous areas in the northeastern States, should have active community protection plans for coping with tornado situations.

The mathematical chance that a specific location will be struck by a tornado in any one year is quite small. This low risk factor undoubtedly contributes to apathy toward tornado preparedness planning until a community has suddenly been the scene of a major tornado disaster. However, the low risk for a particular location mujst be weighed against the casualty potential of a tornado disaster in an unprepared community. When these two factors are considered, it becomes apparent that few communities can afford to forego tornado preparedness planning.

Tornadoes have occurred with execptional frequency at particular locations:

—Oklahoma City has been struck 26 times since 1892;

—Baldwyn, Mississippi, was struck twice in 25 minutes on March 16, 1942;

—Two tornadoes 45 minutes apart on May 30, 1879, left a large part of Irving, Kansas, in ruins;

—Austin, Texas, was struck twice in rapid succession on May 4, 1922; and

—Codell, Kansas, was struck on May 20, 1916, again on May 20, 1917, and a third time on May 20, 1918!

Not many people in any of the above places would feel justified in assuming that it would necessarily be a long time until the next tornado occurred. Similarly, no one in a location that has not yet experienced a tornado should assume that there will *never* be one there. In the area of the battle between the warring air masses, it is wise to be prepared for the worst.

Major Tornadoes

The most death-dealing series of tornadoes on record occurred during the late afternoon on March 18, 1925, in portions of Missouri, Indiana, Illinois, Kentucky, and Tennessee. Eight separate and distinct tornadoes were observed. One of these killed 689 persons, injured 1,890 and caused more than 16 million dollars in property damage. The other seven tornadoes of the series increased the total loss of life to 740 and contributed significantly to the total casualty and property damage.

Another major series of tornadoes killed 268 people and injured 1,874 in Alabama on March 21, 1932. Property damage amounted to approximately 5 million dollars.

The outbreak of 37 tornadoes on Palm Sunday, April 11, 1965, killed 257 people and injured over 5,000 persons in the Midwest. Associated property losses were in the millions of dollars.

Characteristics of Severe Thunderstorms

Severe thunderstorm clouds are the breeding-places for tornadoes, and have the same characteristics as the clouds directly associated with tornadoes except that they do not have rotating pendants extending to the ground, and the sounds characteristic of tornadoes are lacking. However, severe thunderstorm clouds sometimes produce funnel clouds (which are incipient tornadoes) that rotate and are pendant from the parent cloud, *but do not reach the ground.*

Severe thunderstorms occur much more frequently than tornadoes, and in the same areas; and their destructive effects on trees, power lines, houses, mobile homes, and crops are well-known. Deaths and injuries resulting from lightning, strong nonrotating winds, and large hail can be reduced by adequate warning and rapid, well-organized rescue operations and medical assistance.

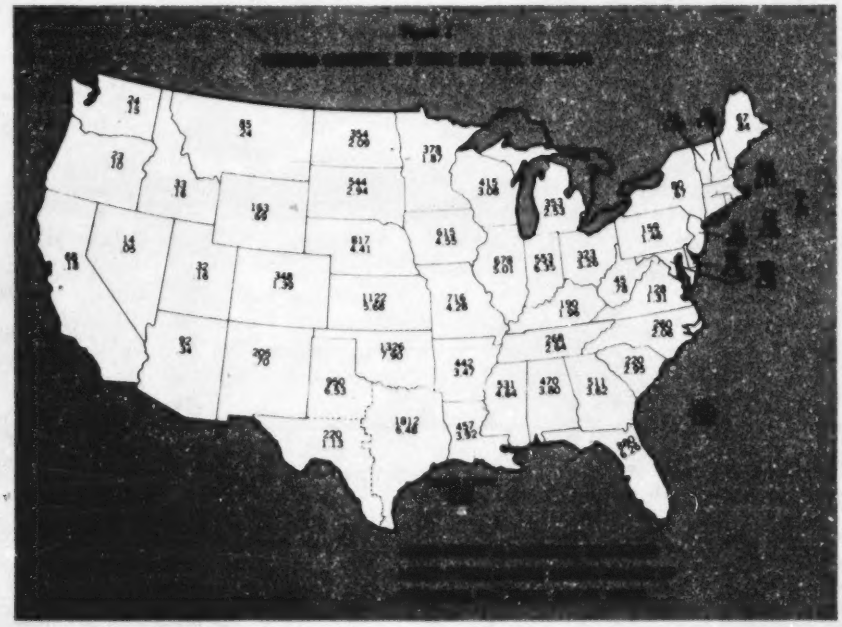


Figure 2
DEATHS FROM TORNADOES, 1953-1971

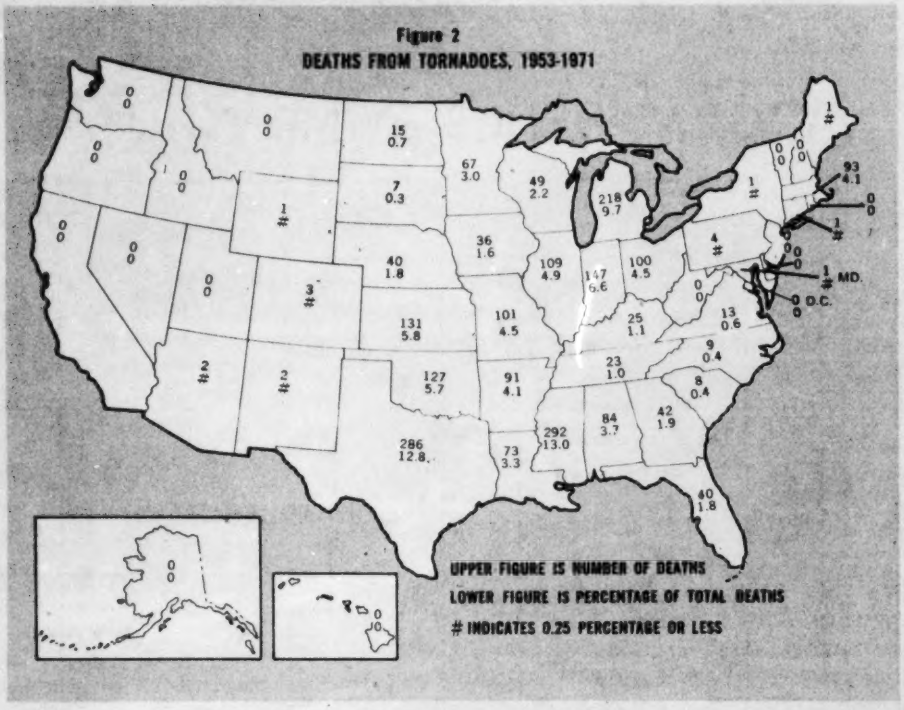


Figure 3
THREAT RATING FROM TORNADOES, 1953-1969

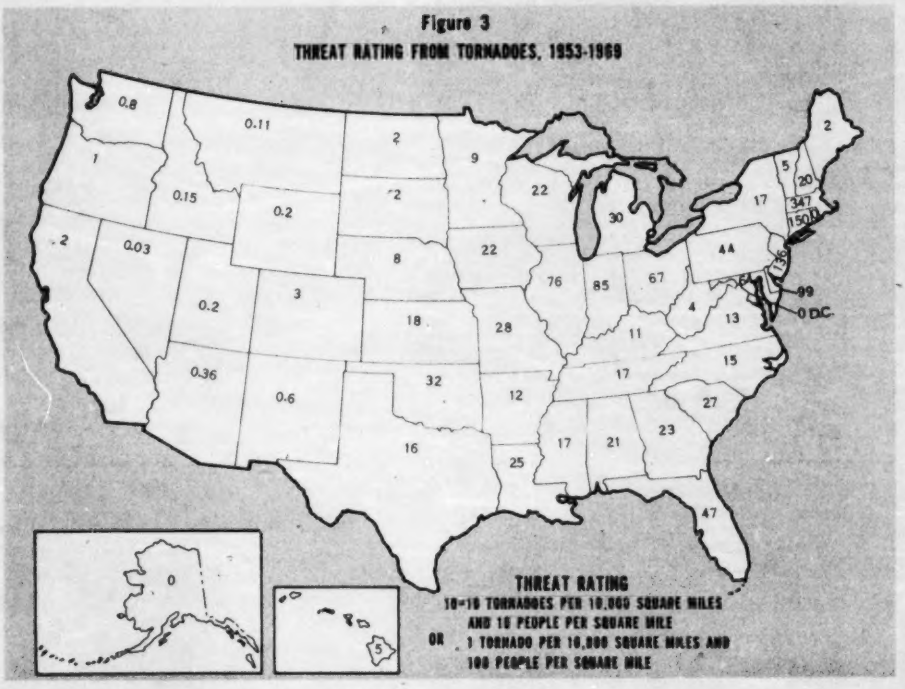
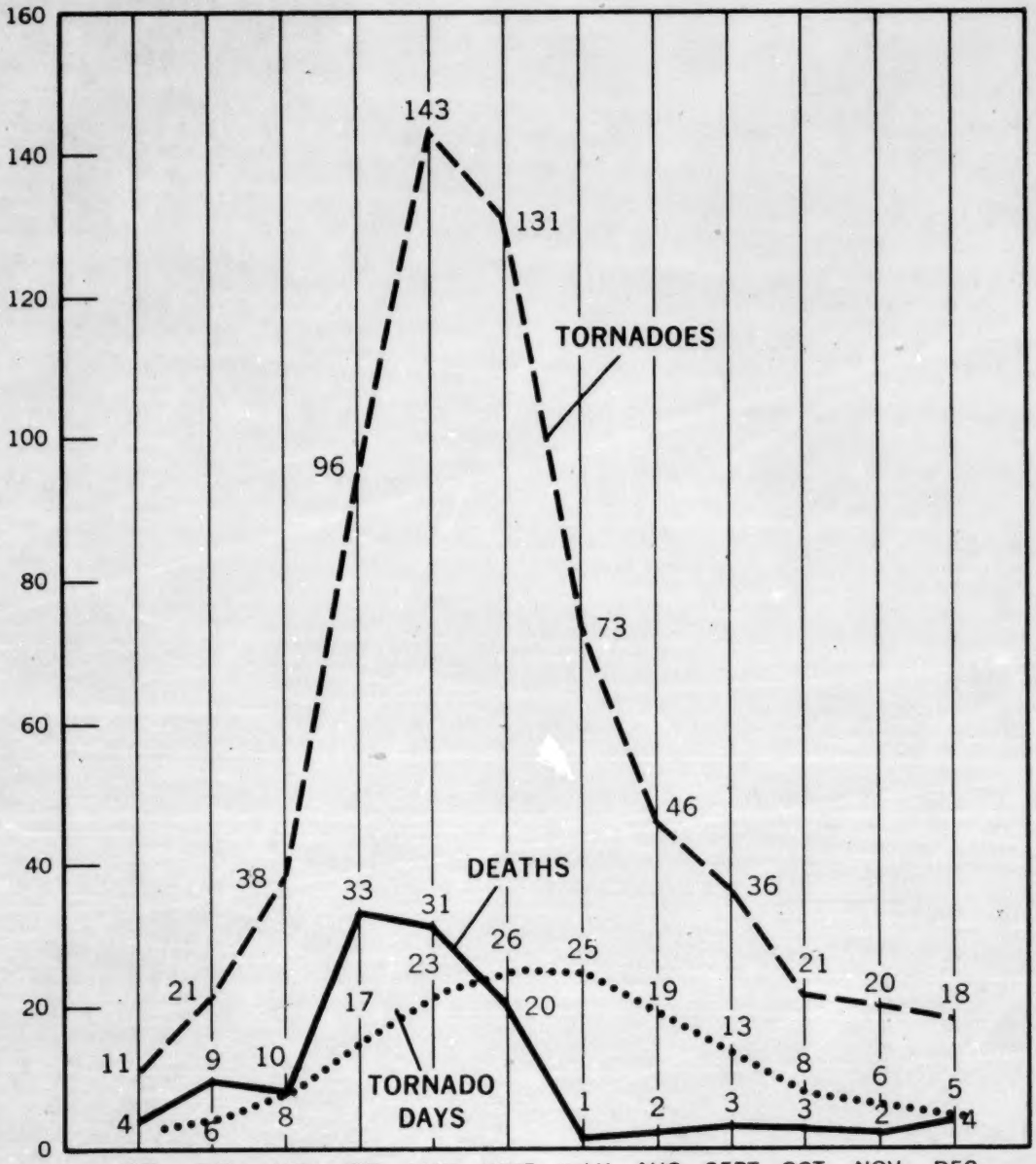


Figure 4

TORNADO INCIDENCE BY MONTH 1953-1971



* U. S. GOVERNMENT PRINTING OFFICE : 1978 281-067/360